

# **Bacteria TMDL Development for Bear Garden Creek**

**Final Public Meeting**

**Arvonias Firehouse**

**Arvonias, VA**

**October 4<sup>th</sup>, 2011**



**THE Louis Berger Group, INC.**



# Agenda

- Meeting Objective
- Impaired Segments
- Watershed Characterization
- Potential Bacteria Sources
- Bacteria Source Assessment
- Technical Approach
- TMDL Allocations
- Next Steps

# Objective

- To present and review the steps and the data used in the development of a Bacteria TMDL for the 303(d) listed segment in the Bear Garden watershed
- To present the TMDL results

# Bacteria Impairments

## Based on VADEQ 2010 303(d) List

**TMDL ID: VAC-H20R-01-BAC**

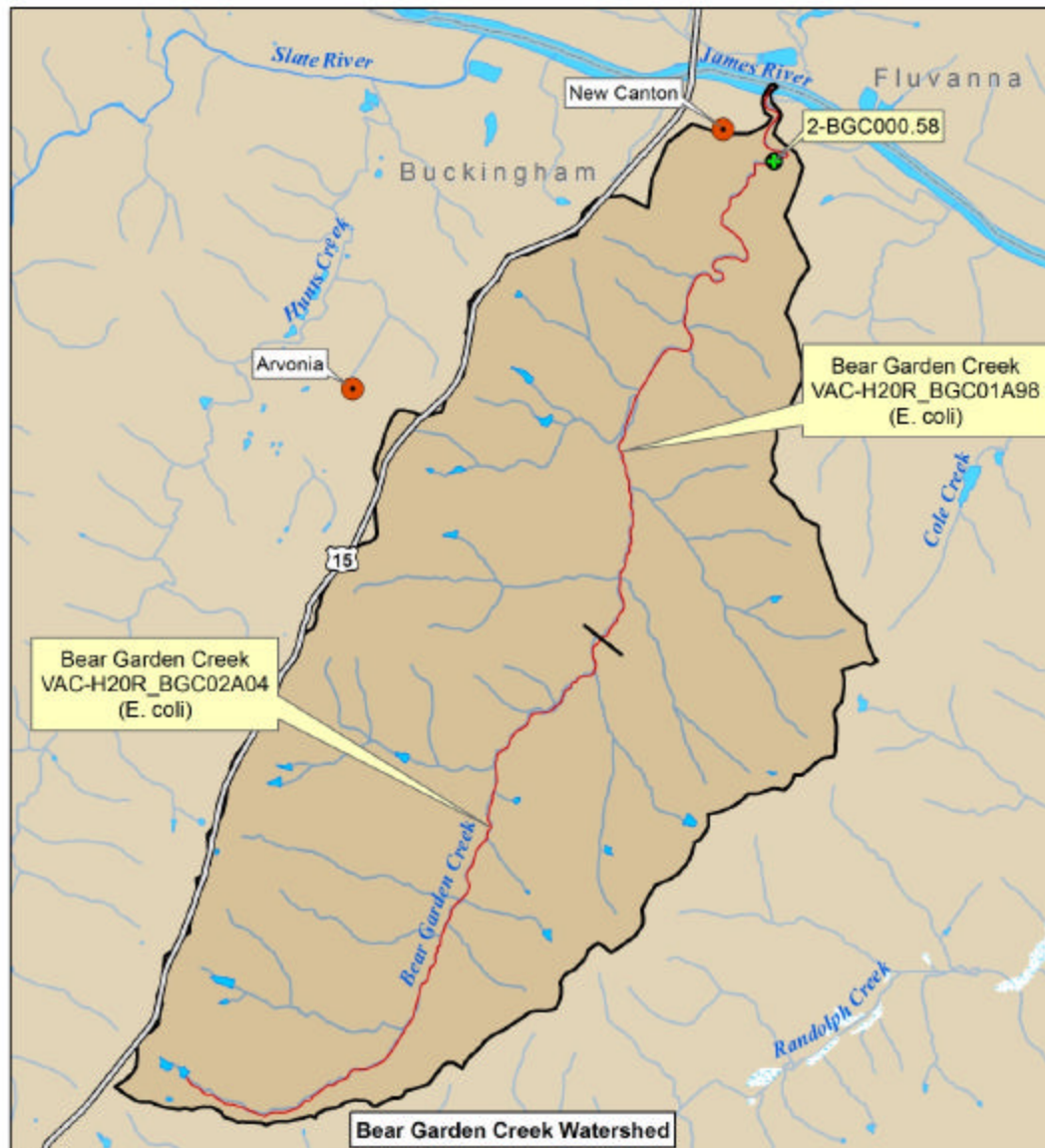
### Assessment Units:

- VAC-H20R\_BGC01A98 (4.67 mi)
- VAC-H20R\_BGC02A04 (4.51 mi)

Bacteria Impairments include the entire headwaters of Bear Garden Creek and extends downstream to the mouth at the James River.

The segment was first listed in 2010 for E. coli bacteria impairment (2/12 violations, station 2-BCG000.58).

- Bear Garden Creek Total Area: 9,239 acres
- Located within the Borders of Buckingham County
- Major Roads: State Highway 15 (James Madison Hwy)



**Legend**

- VADEQ Water Quality Station
- City
- Bear Garden Creek Watershed
- County
- 303(d) Impaired Segment
- Waterbody
- Stream

**Major Roads**

Road Type

- Interstate
- US Hwy
- State Hwy
- Other

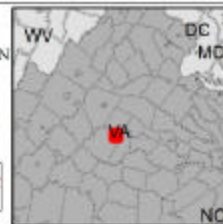


Sources: USGS, VADEQ, ESRI  
Projection: NAD 1983 UTM Zone 17N

0 0.5 1  
Miles



nrc Louis Berger Group, Inc.



# Bacteria Water Quality Standards

VADEQ specifies the following criteria (9 VAC 25-260-170) for primary contact recreational uses in freshwater:

## **E. coli:**

- **126 CFU\*/100ml (geometric mean: applies to 4 or more samples obtained in 1 calendar month)**
- **235 CFU\*/100mL (no more than 10% of the total samples shall exceed)**

**\*CFU = colony forming units**

# E. coli Data Summary: Bear Garden Creek

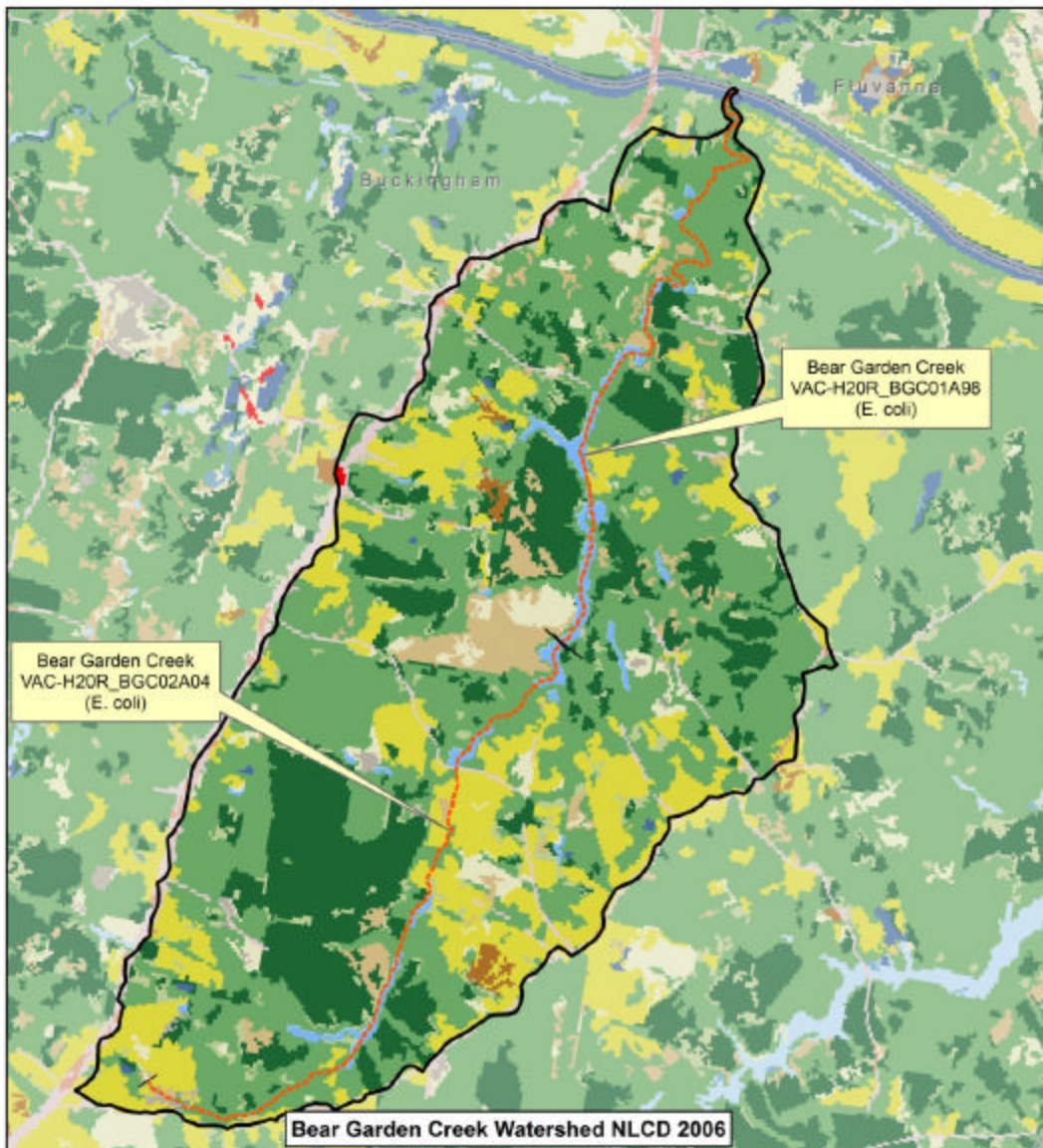
Station ID	Number of Samples	Dates Sampled		CFU/ 100 mL		Total Exceed.*	Total % Exceed.
		First	Last	Min	Max		
2-BGC000.58	12	1/30/ 2007	11/24/ 2008	25	1500	2	17%

\*Exceedances of the E. coli criterion of 235 CFU/100mL

# **Watershed Characterization**



# Landuse



**Bear Garden Creek Total Acres: 9,239**

**69.6% Forest (6,432 acres)**

**16.9% Agriculture (1,558 acres)**

**8.2% Other (762 acres)**

**3.1% Urban (285 acres)**

**2.2% Water/Wetland (202 acres)**

**Based on National Land Cover Database 2006**



# Potential Bacteria Sources

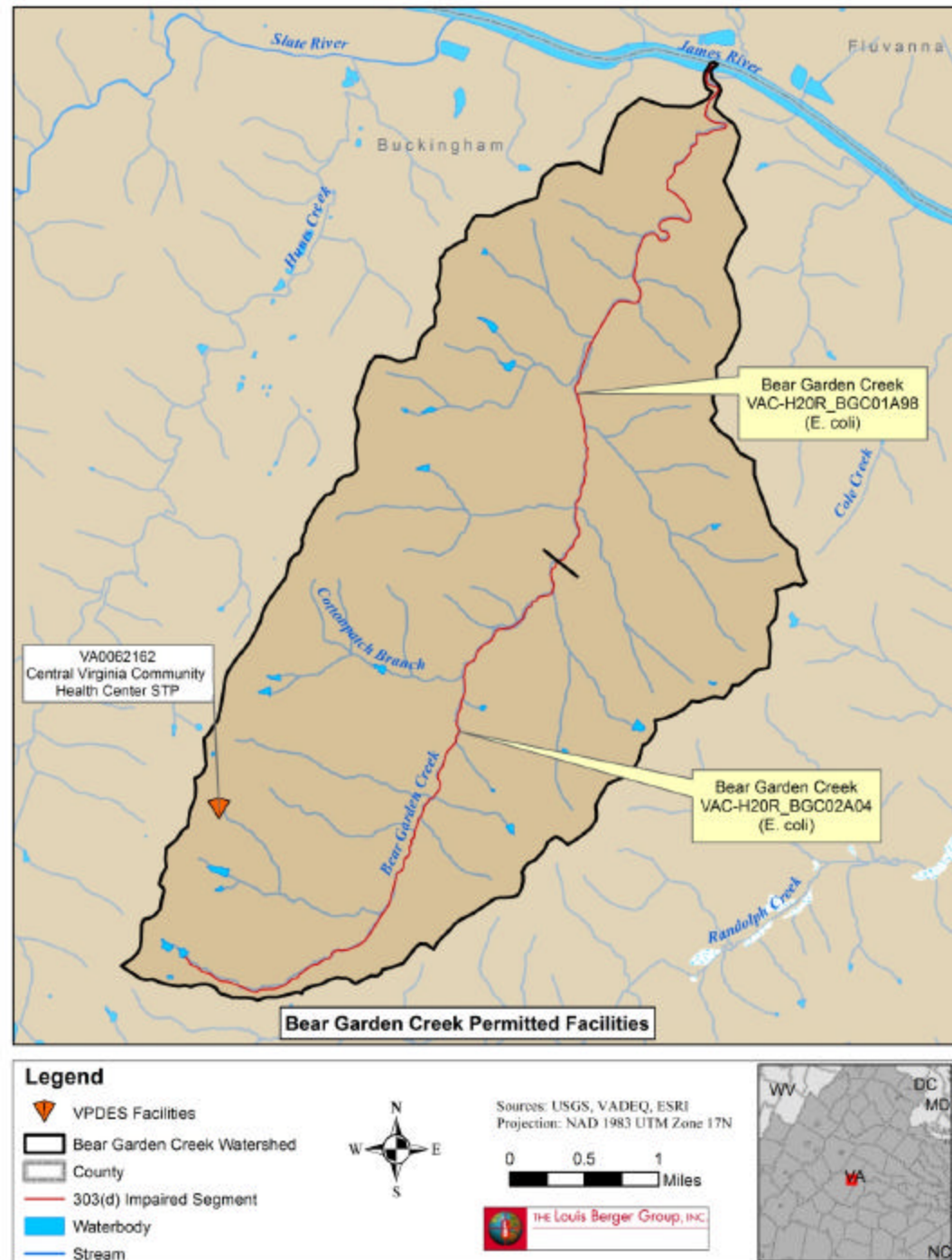
Address bacteria loading from:

- Human Sources (permitted point sources, septic “failing or improperly functioning” systems, straight pipes)
- Livestock
- Wildlife
- Pets

# Permitted Facilities

Permit Number	Facility Name	Outfalls	Receiving Stream
VA0062162	Central Virginia Community Health Center STP	1	Bear Garden Creek Tributary

There were no exceedances of the E. coli limit for the Central Virginia Community Health Center STP



# Numbers on Septic Failures and Straight Pipes

**Counties in the watershed include: Buckingham**

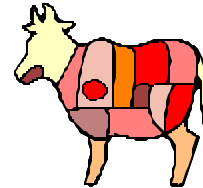
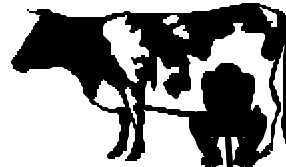
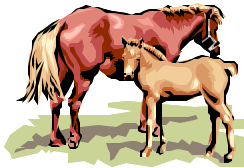
Population <sup>1</sup>	Number of Houses <sup>1</sup>	Number of Houses Public Sewer <sup>2</sup>	Number of Houses on Septic Systems <sup>2</sup>	Number of Houses on "Other Means" <sup>2</sup>	Number of Houses with a Failing Septic System <sup>3</sup>
555	242	18	203	21	24

<sup>1</sup> Census 2009 estimates

<sup>2</sup> Based upon 2009 census estimate and ratio of parameter: 1990 census

<sup>3</sup> Based on a septic failure rate of 12% (VA DEQ 2005)

# Livestock Estimates



Livestock	Total
Beef Cows*	700
Milk Cows**	110
Other Cattle**	175
Hogs/Pigs**	625
Sheep and Lambs**	30
Chickens*	185,000
Horses*	85
*Source: Peter Francisco SWCD	
**Source: 2007 USDA Agriculture Census	

\*Data available from the USDA 2007 Census of Agriculture Report for the state of Virginia at [http://www.agcensus.usda.gov/Publications/2007/Full\\_Report/index.asp](http://www.agcensus.usda.gov/Publications/2007/Full_Report/index.asp)

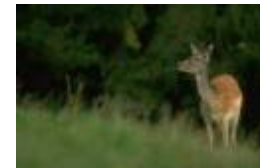
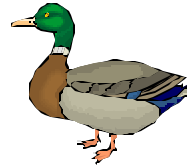
# Biosolid Estimates



Biosolid	Acres	Estimated Tons/acre per yr	Tons of Biosolid per year
Nutriblend	125.9	4	504
Synagro	327.9	4	1,312
Total	453.8	-	1,815

**DEQ Estimated 100,000 CFU/g  
of Fecal Coliform for biosolids**

# Wildlife Estimates: Typical Densities



## Typical wildlife densities, summarized by DGIF:

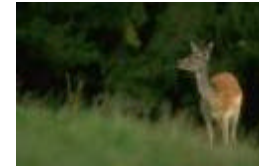
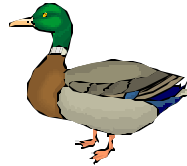
Wildlife Densities in the TMDL Watersheds*		
Wildlife type	Population Density	Habitat Requirements
Deer	17/square mile**	Entire watershed except wetlands, open water, medium/high intensity development
Raccoon (low density)	10/square mile	Upland forest
Raccoon (high density)	50/square mile	Bottomland forest, marsh, swamp, along streams
Muskrat	8 animals/mile	Medium sized stream intersecting pasture fields
Beaver (low density)	1.0/mile	Permanent streams and rivers
Canada Goose	<a href="http://migbirdapps.fws.gov/">http://migbirdapps.fws.gov/</a>	Based on particular strata for watershed area
Mallard		
Wood Duck		
Black Duck		

\* Source: Department of Game and Inland Fisheries (DGIF)

\*\*Source: UVA population model density estimate



# Wildlife Estimates



Wildlife Type	Count
Deer	230
Raccoon	350
Muskrat	20
Beaver	40
Canada Geese	80
Mallard	10
Wood Duck	10



# Pet Estimates



Households	Cats	Dogs
242	175	150

## **Pet inventories based on:**

- Cats: 0.709 per household and
  - Dogs: 0.629 per household
- American Veterinary Medical Association (AVMA) 2007 estimates

# Technical Approach

## ➤ Bacteria Source Assessment

- Identify and assess all potential sources of bacteria in the Bear Garden Creek watershed

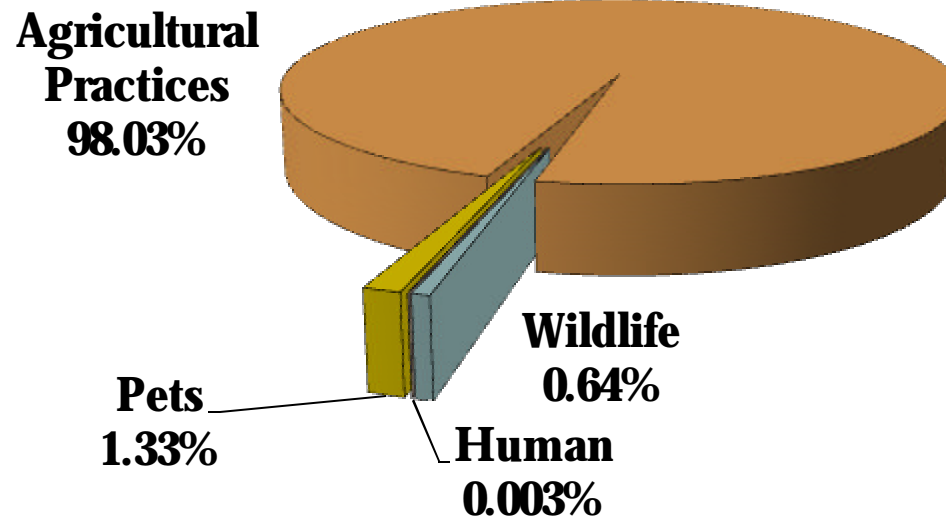
## ➤ EPA's Bacteria Indicator Tool

- Estimate bacteria contribution from multiple sources (agricultural practices (livestock/biosolids), human, pets, wildlife) and direct input of bacteria to streams from grazing livestock and failing septic systems
- Estimate daily accumulated bacteria load per acre for each source
- Estimate the distribution of the daily accumulated bacteria load

# Distribution of the Bacteria Load

## Bacteria Contribution by Source

■ Agricultural Practices   ■ Wildlife   ■ Human   ■ Pets



# Technical Approach

Bacteria Load Duration Curves (LDC) (US EPA, 2007) :

- Characterizes bacteria loads at different flow regimes
- Displays the relationship between stream flow and loading capacity
- Identifies the critical flow condition class needed to meet the TMDL
  - LDC approaches assume that if the highest percent reduction associated with the difference between the existing loading and the load duration curve is achieved, then the water quality standard will be attained under all other flow conditions
- Specifies the percentage of time during which bacteria loads are equaled or exceeded

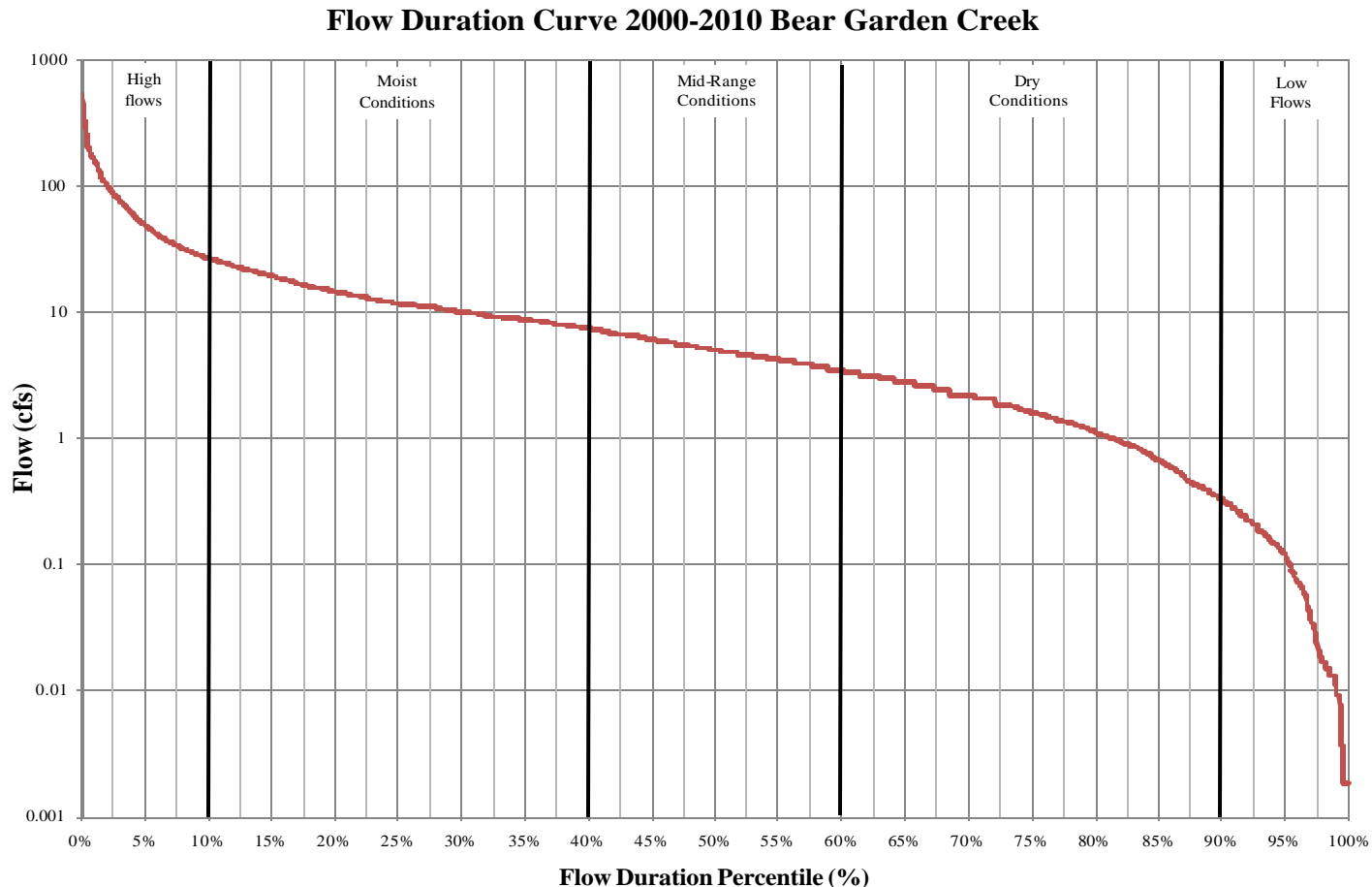
# Technical Approach

- Select a reference watershed for a continuous flow record
  - There is no USGS gauge on Bear Garden Creek
  - A 10 year flow record was selected (2000-2010) at Po River (USGS 01673800) was chosen based on the following:
    - Same Ecoregion - Piedmont
    - Vicinity - approximately 48 miles away
    - Similar land use –

Po River and Bear Garden Creek Landuse Comparison (NLCD 2006)		
Landuse Category	Po River	Bear Garden Creek
Developed	5.4%	3.1%
Agriculture	12.9%	16.9%
Forest	57.8%	69.6%
Wetland	8.1%	2.0%
Water	0.7%	0.2%
Other*	15.2%	8.2%
Total	100.0%	100.0%
*Includes: Scrub/Shrub, Grassland/Herbaceous, and Barren Land		

# Technical Approach

- Develop flow duration curve using a continuous flow record
  - The flow was pro-rated for Bear Garden Creek and divided into five hydrologic condition classes (high flows, moist conditions, mid-range conditions, dry conditions, and low flows)



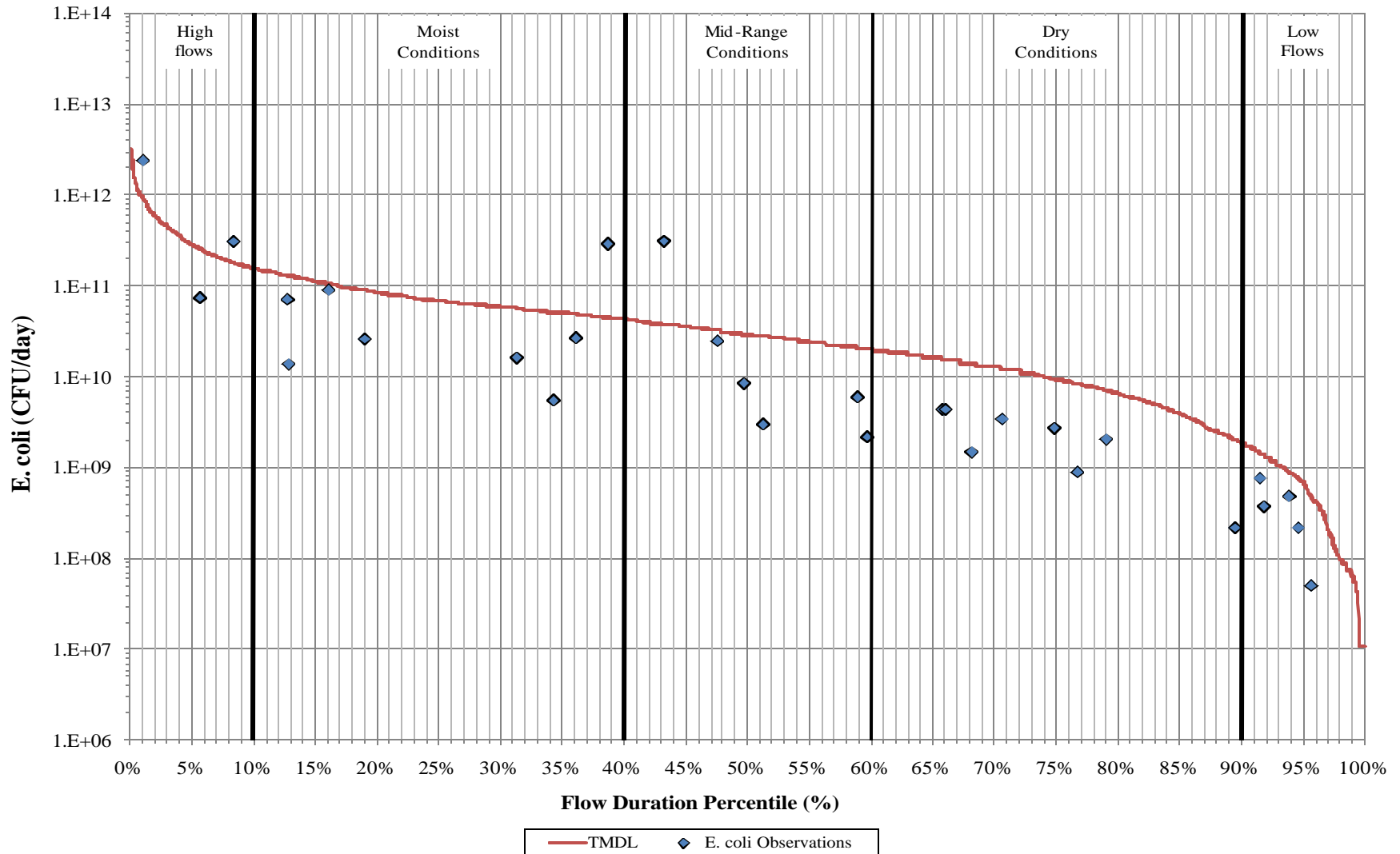
# Technical Approach

- Develop a load duration curve for all flow regimes under load at bacteria criterion and existing bacteria load:
  - Load at bacteria criterion: Use estimated flow from nearby USGS Gauge (Po River) and the bacteria criterion (235 CFU/100mL)
  - The Wasteload Allocation (WLA) load was subtracted from the Load Duration Curve in order to reflect a non-point source curve.
    - Following VADEQ permit guidelines; the WLA was calculated using the geometric mean standard of 126 CFU/100mL, not the instantaneous standard of 235 CFU/100mL
  - Existing bacteria load: Use estimated flow based on nearby USGS Gauge (Po River) and measured instream bacteria data collected by VA DEQ (2-BGC000.58) from 2000-2008
    - Fecal coliform data from 2000-2003 were translated into E. coli data using a VADEQ approved translator .



# Technical Approach

**E. coli Load Duration Curve 2000-2010 Bear Garden Creek**



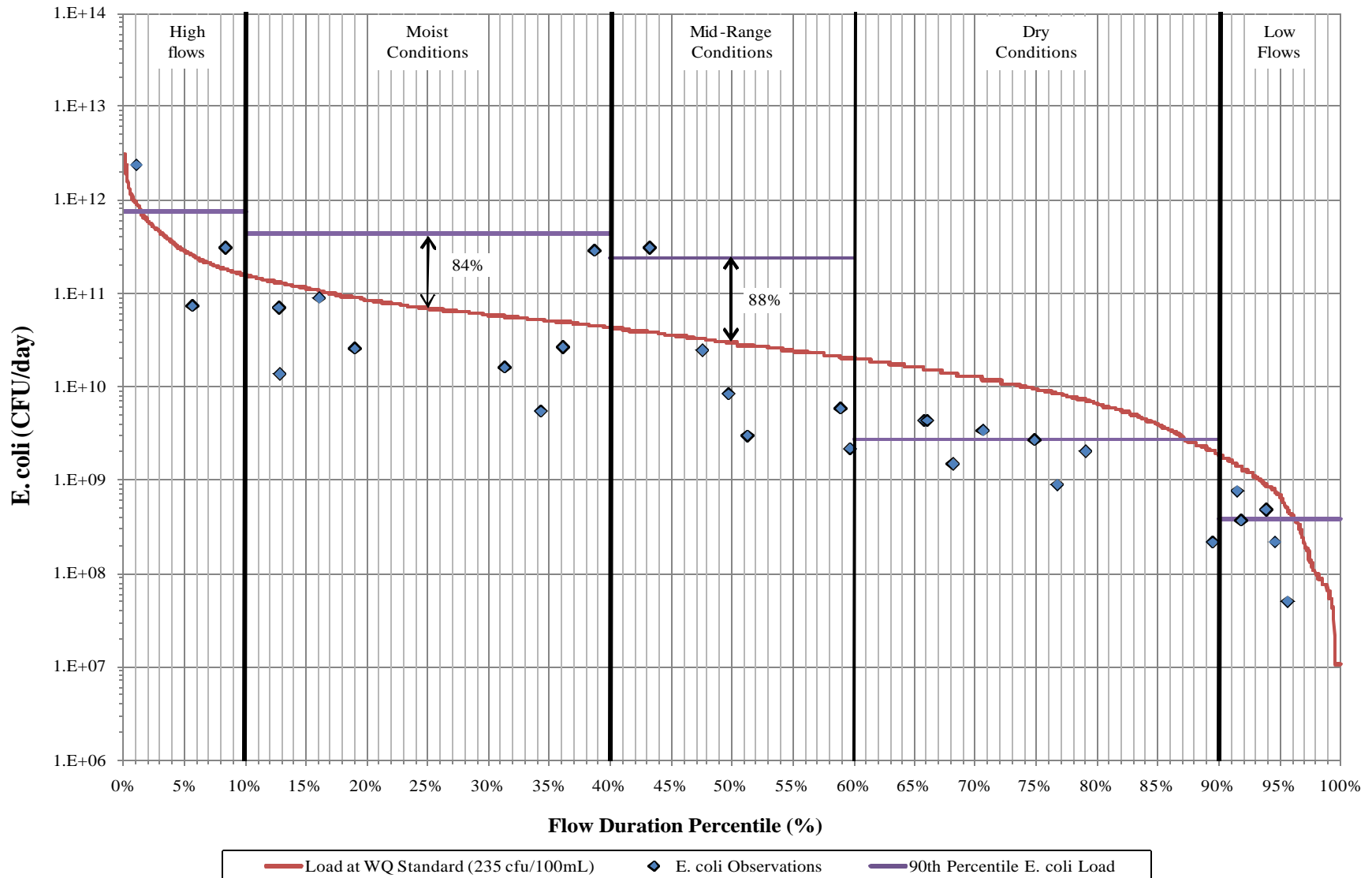
# Technical Approach

- Calculate existing bacteria loads under each flow regime
  - Existing loading is calculated as the 90<sup>th</sup> percentile of measured E. coli concentrations under each hydrologic condition class multiplied by the flow at the middle of the flow exceedance percentile
- Calculate bacteria reductions under the critical flow regime (Mid Range Conditions) using the 90<sup>th</sup> percentile existing bacteria load.
  - The critical condition class is the class with the highest reduction necessary to meet the TMDL
    - In this case it is the Mid-Range Condition Class with a reduction of 88%.
- Allocate the load based on the source distribution estimated from the EPA's Bacterial Indicator Tool

Hydrologic Condition Class	Estimated Existing Loading (CFU/Day)	Allowable Load (CFU/day)	Percent Reduction Required
High flows	7.44E+11	N/A	N/A
Moist Conditions	4.41E+11	6.90E+10	84%
Mid-Range Conditions	2.39E+11	2.91E+10	88%
Dry Conditions	2.72E+09	N/A	N/A
Low Flows	3.84E+08	N/A	N/A

# Technical Approach - LDC

**E. coli Load Duration Curve 2000-2010 Bear Garden Creek**



# TMDL Expression

$$\text{TMDL} = \sum \text{LA} + \sum \text{WLA} + \text{MOS}$$

LA = Load allocation (nonpoint source contribution)

WLA = Waste load allocation (point source contribution)

MOS = Margin of safety

# TMDL Allocation Strategy

- Waste Load Allocation is based on permitted flow (design flow) and the E. coli permit limit (geometric mean standard of 126 CFU/100mL) from the Permitted Facilities in the Bear Garden Creek Watershed, as well as 1% of the TMDL for future growth.
- Load Allocation is based on the estimated fraction of NPS Loads (using EPA's Bacterial Indicator Tool) from the non urban areas

# Bear Garden Creek Allocations

## Load Allocation

Source	Percent of Load Allocation (%)	Current Load (CFU/day)	Allocated Load (CFU/day)	Required Reduction (%)
Agricultural Practices	98.03%	2.340E+11	2.567E+10	89.0%
Wildlife	0.64%	1.520E+09	1.520E+09	0.00%
Human	0.003%	6.501E+06	0.000E+00	100.0%
Pet	1.33%	3.167E+09	1.584E+08	50.00%
<b>Total</b>	<b>100.00%</b>	<b>2.387E+11</b>	<b>2.878E+10</b>	<b>88.0%</b>

## Waste Load Allocation (Permitted Facility)

Facility Name	Permit No	Design Flow (MGD)	VADEQ E. coli Standard (CFU/100mL)	Wasteload Allocation (CFU/Day)
Central Virginia Community Health Center STP	VA0062162	0.005	126	2.385E+07

## TMDL Allocation Plan Loads (Counts/day)

WLA (Permitted Discharger + 1% of the TMDL for Future Growth)	LA (non point sources)	MOS (Margin of Safety)	TMDL
<b>3.148E+08</b>	<b>2.878E+10</b>	<b>IMPLICIT</b>	<b>2.909E+10</b>

# Next Steps

- 30 day comment period: Oct. 4<sup>th</sup> – Nov. 4<sup>th</sup>
- Final Bacteria TMDL Report
- Submit Final Bacteria TMDL to DEQ and EPA



# Local TMDL Contacts



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# Additional Slides

# Water Quality Graph

